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A METHOD FOR
BUDGETARY CONTROL
OF EXPENDITURES

BY

LCDR O. W. DRYER, U. S. NAVY

A TERM REPORT

FOR

DOCTOR A. REX JOHNSON
SEMINAR IN COMPTROLLERSHIP
NAVY GRADUATE COMPTROLLERSHIP COURSE

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CHAPTER I

A CONCEPT OF BUDGETARY CONTROL

Objectives

The objectives of this paper are to present a brief concept of budgetary control, the relation between management problems and control of the budget, and an application of statistical quality control methods in administering a budget program. In a popular sense, budgetary control embraces two broad areas of administration or management; (1) budgeting, and (2) control. Budgeting is the planning process involving the assembly of information to determine estimates and forecasts of operations, and the application of this information to formulate and establish a program or objective. Control is the process of administering this plan by using the established program to measure current operations. The results are then analyzed and action is initiated, if necessary, to modify the program or to investigate and correct causes of discrepancies or variances. It is not intended, in this paper, to discuss the various considerations involved in the process of formulating and installing a budget program in a business or public enterprise. Rather, this study is an attempt to present a practical application of standard business procedures to the administration of a budget program. This is the control phase of the budgeting process, and it is further distinguished in this presentation by a concept of "quality control."

Progress of Budgeting in Business and Government

Budgeting is not a recent innovation in business management or public

administration. As early as 1911 two states, California and Wisconsin, adopted a budget system, and the first national budget was transmitted to Congress by President Harding on December 5, 1921. But private corporations did not give widespread consideration to a budget program until the value of the public budget had been demonstrated, and not until industry was confronted with disaster by the 1920 deflation.[1] It was, therefore, in the field of public finance that the value of the budget was first demonstrated. Success in this field extended itself to acceptance of budgeting by private business as a useful tool in the efficient and successful management of industry. The more recent growth of private and public enterprises, with its resulting hierarchy of specialized functions, has created a greater need for comprehensive planning to systematically manage these functions. The budget is, consequently, growing in importance as a management tool not only for the executive in industry, but also for the administrator in government. A popular conception of budgeting is that it is a device for planning. In its increasing present use, a budget is more than just a plan; it is a means of financial and administrative control. In the process of formulating the budget, an operating plan is developed which becomes a goal or aiming point for operations during the ensuing period. The administering of this plan is equally as important as its formulation. Therein lies the control aspects of the budgeting process. Discrepancies will occur and corrections of some nature may be required in either the plan or in current operations. The important thing is to know when these variances occur, to be able to determine the causes and make the necessary corrections. An effective method of budget control will provide this information. The

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[1] National Industrial Conference Board, Budgetary Control in Manufacturing Industry (New York: National Industrial Conference Board, Inc., 1931), pp. 4-8.

problem -- what type of information does management need to obtain effective control of a budget?

Management Problems

Management needs more than just an operating plan based on estimates or past experience. It needs a systematic method of determining how efficiently the operations of the enterprise are being conducted in relation to the goal or plan. It must have a timely method of determining how much of the plan has been completed, and how much remains to be done. It must have an effective method for analyzing progress as related to the objective. It must be warned immediately of discrepancies or variances, and it must be able to determine whether these variances are of sufficient magnitude to warrant investigation. But this information alone is not sufficient. Management must be able to recommend an intelligent approach to any problem that arises. Arthur E. Buck synthesized these requirements very nicely by saying that, in order to carry out the budget, the executive should have at his command two essential things; (1) a modern and suitable administrative organization, and (2) up-to-date and effective devices and methods of administration.[2]

The Role of Statistics in Budgetary Control

An increasing number of executives are turning to statistics as one of these effective devices and methods of administration. The application of statistical procedures enables management to reduce the complexity of operational information to quantitative measurements from which intelligent decisions can be made. By reducing the masses of detailed data to an understandable form, a budget program may be more easily controlled because

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[2] Arthur E. Buck, Public Budgeting (New York: Harper & Brothers, 1929), p. 431.

danger signals are lighted and corrective action can be taken before it is too late. Although statistics can be used as a tool in many phases of management, its application to the budget program will most likely be concerned with finances or operating costs. Therefore, the remainder of this study will be limited to a discussion of budgetary control of expenditures, and a unique application of statistics to this problem will be presented as a useful device for effective control of expenditures in certain budget programs.

CHAPTER II

BUDGETARY CONTROL OF EXPENDITURES

Actual Versus Estimated Expenditures

An expenditure budget is essentially a program of estimated costs of operations for the budget period. During the process of formulating this cost program, all the various factors are considered that may have an effect on the operations during the period. Information from past operations are analyzed and projected in terms of expected operations. Political and economic factors are also evaluated to determine the overall effect of these influences. After considering all available information, forecasts are made in regard to the effect of the various trends on the operations during the budget period, and basic policies are established as broad control lines. Based on the results of the overall study and evaluation, an expenditure program is formulated as a goal for operations during the period.

Because of the necessity for Congressional approval of a Federal public budget by formal appropriation of funds to carry out the program, a public expenditure budget is usually more inflexible than in an industrial or other private organization. Therefore, in a public budget, expenditures must be rigidly analyzed and controlled, and the expenditure budget is continuously used to measure current operations. A public agency formulates its complete program for the budget period in terms of dollar costs or requirements and it defends this position in the process of requesting Congressional approval to expend that amount of public money to consummate

the program. Congress approves this program by appropriating funds for carrying out the various objectives. The agency is, therefore, committed to certain limitations on expenditures during the period, and it is responsible for the intelligent control of operating costs in order to complete the various functions that were included in the overall program as presented to Congress. Changes can of course be made, but as a general rule such changes are more difficult in a public program than in a private organization. Analysis of actual expenditures versus the estimated expenditures is therefore essential if the budget is to be used as a means of financial and administrative control.

The overall budget program will normally be classified by various programs, functions or objects, and additional segregation will be made in carrying out the various objectives. At the operating level the programs will be broken down into estimated expenditures for various periods, possibly weekly, semi-monthly, monthly, bi-monthly, or quarterly. The length of this period will usually depend on the type of activity, but in general it can be assumed that the extent of expenditure control decreases as the period becomes larger. The end of each period then becomes a control point for measuring actual expenditures versus the estimated expenditures. It would be unreasonable to expect the actual expenditures to completely agree with the budgeted amounts. Unless all expenses were fixed in every respect, it would be impossible to forecast to such a degree of accuracy. A variation between the actual and estimated expenditures will, therefore, be expected throughout the entire budget period. At one point it may appear that costs have been excessive and additional funds will be required to complete the program. At another point during the year, it may appear that expenditures have decreased to a level which will result in an excess of

funds. Throughout the entire period of operations two basic requirements must be resolved; (1) all phases of the overall program must be continued as planned, and (2) expenditures must be controlled to effectively administer the overall program throughout the entire budget period. This concept of expenditure control means that it is essential that variances between the actual and estimated expenditures be analyzed in terms of effect on the operations for the remainder of the budget period. In other words, is this variance significant; is it larger than should be expected; will future operations continue along the same trend; or, will expenditures during the next period bring the accumulated costs in line with the estimated amounts? These are difficult questions to answer without an established plan for administering the program efficiently. Possibly the variances are beyond the control of the activity and result from some unexpected influences. None of these problems are necessarily fatal if they are detected when the signal is first evidenced. Corrective action can be more easily initiated at the outset than later when emergency measures may be necessary. The task then is to be able to determine when the variances in the budget program are significant and what the causes for these variances are so that corrective action can be initiated before it is too late.

Significance of Variance from the Estimate

When are variances between the actual and the estimated expenditures significant? If this question was presented to one hundred people, the result would probably be one hundred different answers. For purposes of this discussion, a significant variance is defined as one that indicates that: (1) current expenditures are not being controlled effectively in accordance with the estimated costs, and (2) the cause for the variation can be isolated and assigned to definite sources. If an effective system

for controlling expenditures is established, the amount of variance from the budget is detected almost as soon as the discrepancy occurs. However, the amount of variation by itself is meaningless unless some yardstick or measure is applied which signals that corrective action is or is not necessary. If a trend is being established by variations in consecutive periods, that may be a signal to initiate an investigation to determine the cause of the discrepancy. If the rate of expenditures is slow and no change is being evidenced, that may be sufficient information to warrant action of some nature. On the other hand, expenditures may be considered excessive and an investigation to determine the cause is obviously in order. But what is the crucial point? What are the danger signals? How large can the variance be before it is significant? At what point is the difference between actual and estimated expenditures considered great enough to warrant special study and evaluation? Again, a number of people would probably arrive at the same number of different conclusions, and each approach would possibly have particular merit. Past experience would undoubtedly be a useful yardstick. An efficient accounting system would also aid management considerably in deciding when to initiate corrective action. Management is continuously in search of new tools to aid in effective control of expenditures, and statistical procedures are being utilized more and more by executives and administrators to assist in detecting these discrepancies. One such procedure that has been used for some time in the production phases of management is statistical quality control.

A Statistical Approach to the Problem

Although statistical quality control is normally used as a tool in production processes, the basic principles are also applicable to expenditure control, and for that matter to many other uses. The principles of

statistical quality control are generally said to have been developed by Walter A. Shewhart of the American Telephone and Telegraph Company in the early 1920's, but it was not until the pressure of the production needs during World War II that its value was fully appreciated.[3] The application of quality control methods to budgetary control cannot be readily visualized without some understanding of these principles. Statistical quality control has been defined as simply a statistical method for determining the extent to which quality goals are being met, and for indicating whether or not the variations which occur are exceeding normal expectations.[4] Application of this definition to a financial budget means that if an expenditure goal or standard is established, it will be possible by application of statistical quality control methods to determine the extent to which this goal is being met. In addition, it will be possible to determine whether the variations between actual and estimated expenditures are exceeding normal expectations. Off hand, it appears that this is the complete answer to the problems mentioned previously; that is, when are variances great enough to warrant investigation or corrective action. However, the phrase "exceeding normal expectations" covers a multitude of connotations and must be fully understood in connection with statistical procedures. Therefore, in the following chapter of this study, the basic principles of statistical quality control will be more fully explained and an application to budgetary control will be illustrated in detail.

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[3] J. R. Riggleman and I. N. Frisbee, Business Statistics (New York: McGraw-Hill Book Company, 1951), pp. 425-426.

[4] Ibid., p. 426.

CHAPTER III

APPLICATION OF QUALITY CONTROL METHODS TO THE BUDGET

The term "quality Control" is normally identified with a manufacturing or production process, and its application to budgetary control may be difficult to visualize. However, the concept is essentially the same when considered in terms of the objective. In a manufacturing industry the objective is, generally, to determine the degree to which the production processes are conforming to established requirements or standards. In this manner, the Company is able to determine when the production process is out of control, that is not operating as desired, or when to accept or reject certain items. In this sense, quality is interpreted as a standard of conformance to a design or specification, rather than to inherent features such as appearance, luxury features, durability, etc. This application of "quality" can be utilized in measuring any number of operations or activities. In budgetary control, management attempts to conduct the operations of an activity in accordance with an established plan. The expenditure budget is an estimate of the financial needs of the organization during the budget period. This budget or plan then becomes the standard or operating specifications and, as in the case of the manufacturing enterprise, quality control methods can be employed to determine when actual expenditures are not being conducted according to this plan. Instead of the production process being out of control, the expenditure process is out of control, and instead of realigning or adjusting machinery, it is necessary to revise the

expenditure program. However, in the case of the budget, it is usually more difficult to determine the cause for a variation from the established standard. Normally, an investigation of some nature will be required before the cause can be definitely determined and corrective action initiated. This is a measure of the quality of the control of expenditures, not from a standpoint of ability of the administrators of the program or of the accounting devices used, but from the standpoint of being able to determine when actual expenditures vary sufficiently from the budget to indicate that the normal processes are not operating and corrective action may be required to bring current expenditures in line with the plan.

But "quality control" is concerned not only with a concept of quality, but also with a certain degree of control. Since statistical procedures are employed in the application of quality control methods, this degree of control becomes one of prediction within limits, or the probability that a certain observation will fall within established limits. This limitation in the application of control must be accepted because statistics are based largely on the mathematical theory of probability. Therefore, the degree of control exercised, in the application of quality control methods in a manufacturing industry, is obtained by the process of determining the amount of variation from a standard and the probability of that variance occurring within certain limits. Likewise, in the case of an expenditure budget it is possible to determine, at least approximately, the probability of certain variations from the budget occurring due to chance causes. If this degree of probability is acceptable, the variation from the budget is not considered significant and corrective action is not required. Normally the reverse procedure is employed; that is, a specific level of confidence or probability will be established as an acceptable limit for

all variations from the budget or standard. Then if the variations exceed these limits, the probability of occurrence due to chance is not acceptable and the variation is considered to be significant and due to some assignable cause. Consequently, an investigation would be initiated to determine the cause and corrections would be made as necessary. In this manner the concept of control is employed as a signaling device to warn management when control limits are being exceeded. The action taken from that point depends upon the activities of the particular organization. Possibly the causes can be easily determined and eliminated. In other cases the causes may be known but corrective action is not feasibly. The important thing, however, is that the signal was lighted, and management was aware of the situation. A detailed illustration of an application of quality control to the budget will be presented in the following paragraphs.

Approach to the Problem

The concept of "quality control" as applied to an expenditure budget can be defined as "cost control" within established limits. The term "cost control" is probably more suitable because "quality control" embraces many aspects which are not applicable to controlling expenditures. However, the general method that will be presented in this chapter is one of the standard methods of statistical quality control.

Probably the best manner in which to present this cost or budget control procedure is by illustrating with a specific problem or situation. Therefore, the following hypothetical situation is given to enable a presentation of the procedure in detailed form:

> The Naval Missile Production Center received an allotment of one million two hundred thousand dollars ($1,200,000.00) from the Bureau of Aeronautics for conversion of obsolete airframes to certain guided missiles during Fiscal Year 1952. Production and management personnel at the Center evaluated the overall project in terms of costs and rate of progress and presented a budget of estimated expenditures during the year. A comparison

of the estimated expenditures versus the actual costs incurred is shown in Table 1.

TABLE 1

THE NAVAL MISSILE PRODUCTION CENTER
BUDGET AND ACTUAL COSTS
FOR FISCAL YEAR 1952

Month[a]	Budget Costs	Actual Costs	Variation
July	$40,000.00	$34,788.19	$ 5,211.81
	45,000.00	44,367.12	632.88
August	50,000.00	62,146.11	12,146.11[b]
	60,000.00	57,396.10	2,603.90
September	55,000.00	45,464.13	9,535.87
	65,000.00	38,677.14	26,322.86
October	45,000.00	55,899.27	10,899.27[b]
	60,000.00	42,488.14	17,511.86
November	55,000.00	39,871.42	15,128.58
	45,000.00	55,811.33	10,811.33[b]
December	40,000.00	48,019.17	8,019.17[b]
	35,000.00	60,111.47	25,111.47[b]
January	35,000.00	62,148.23	27,148.23[b]
	45,000.00	57,433.89	12,433.89[b]
February	55,000.00	64,899.10	9,899.10[b]
	65,000.00	50,411.09	14,588.91
March	50,000.00	48,811.13	1,188.87
	40,000.00	49,614.38	9,614.38[b]
April	45,000.00	44,872.07	127.93
	55,000.00	46,813.14	9,186.86
May	65,000.00	45,811.27	19,188.73
	60,000.00	52,117.54	7,882.46
June	50,000.00	49,419.34	580.66
	40,000.00	41,187.19	1,187.19[b]

[a] Divided into two periods; 1st to 15th, 15th to end of month.
[b] Costs in excess of the budget.

The Project Director received a report on the 16th and 1st of each month comparing the actual expenditures with the budgeted amounts for the previous period, and also the accumulated costs to date. The actual costs did not agree with the estimated expenditures, and he reasoned that it was

not logical that they should agree entirely. But a continuing question arose in regard to the importance of these differences. The aim, of course, was to utilize the entire amount of $1,200,000.00 during the year, which would amount to an average expenditure of $50,000.00 in each of the twenty-four periods. When was the variation significant? When was the expenditure program too far out of line so that the total monies available would not be sufficient at the present rate of expenditure? How large could the variation between the budget and actual costs get before corrective action would be necessary? What were the danger signals or turning points? These were important questions and the answers could have been obtained by statistical quality control methods. The data in Table 1 will be presented in the following paragraphs to illustrate the application of statistical quality control methods to this situation.

The approach to the problem of setting up a cost control system is to first consider the objectives of the procedure that is to be used. The objectives of statistical quality control procedures are to establish control limits that will warn management when operations are not in conformance with the standard, and when the variations from the standard are due to other than chance causes. In other words, control limits are established within which actual costs can be expected to fall if only chance causes are operating. This is accomplished by computing the average or expected expenditure during the budget period, and determining the variation above and below this amount that can be expected due to various chance causes. This variation can be expressed in terms of probability; that is, a definite limit above and below the expected expenditure can be determined which will be exceeded only five percent of the time, if only chance causes are operating. Similar limits can be determined at any level of confidence that is

acceptable for the particular situation. In other words, in a cost control system, limits can be determined within which expenditures can be expected to fall ninety-five percent of the time. If an expenditure exceeds these limits, it can be assumed that the variation resulted from some assignable cause and was not due to chance alone. This is an important signal to management. It warns that certain influences are operating in such a manner that current operations are not conforming to the established plan which, in the case of cost control, is the expenditure budget. It can be expected that variations will occur between the estimated costs and actual expenditures, and this control procedure will warn management when these variations are due to some assignable cause and not to chance fluctuations. Thus, a danger signal is lighted immediately and an investigation can be initiated to determine the cause. Corrective action can then be taken before it is too late. The usefulness and reliability of these control limits depends upon the manner in which they were established. A standard must be accepted as a measure of the expected performance during the period, and the results of the control procedure must be evaluated in accordance with the basis from which the control limits were determined.

Establishing Standards

The first step in setting up a cost control system is to establish cost standards for each of the budget periods. The purpose of these standards is to provide a common basis for comparing actual expenditures with the estimated costs. Since the budget is the Project Director's plan of operations for the overall period, the estimated costs can be related to the standards to develop the expected performance of the actual expenditures during the period. This is accomplished by determining the average ratio of the budget costs to the standards and then computing the variability in

terms of the standard error. Control limits can then be established on a probability basis and actual costs can be measured in accordance with these limits. This procedure will be described in more detail in the following paragraphs.

The first problem is to develop a suitable system of standards. Numerous systems may be acceptable, but it is desirable to establish standards that will compare favorably with the pattern of expected expenditures. In other words, if it is expected that expenditures will be high at first and decrease during the latter part of the year, standards approximating this type of performance should be established. If it is expected that costs will be relatively equal in each of the budget periods, the total amount budgeted for the year could be divided by the number of periods to arrive at a suitable standard for each period. One of the objectives in the problem presented previously in this chapter was to conduct operations in each of the twenty-four periods in such a manner that the entire amount would be expended at the end of the year. Also, no particular pattern or trend is evidenced in the amounts estimated for each period. Therefore, a suitable standard would be the average monthly amount, which if spent over the remaining periods of the budget would expend all of the available funds. This is accomplished by dividing the balance of funds available at the beginning of each period by the number of periods remaining. This is, in effect, the average expenditure for each period plus or minus the accumulated variation from the average extended equally over the remaining periods. Therefore, the cost standard changes for each period in accordance with the expenditures of the previous periods.

The next step in the cost control procedure is to compute the ratio of budget costs to standard costs. The mean ratio can then be established

as the expected performance of the actual expenditures. From this information, control limits can be established and the probability of variations from this mean ratio can be computed. In order to smooth out irregularities from period to period, it is desirable to combine a number of periods and obtain a moving average. A better measure for expected performance would then be the mean of the moving averages. This maneuver also provides two useful tools; (1) a moving range from which the mean range can be easily determined, and (2) the number of periods included in the moving average can be regarded as the sample size, and the number of moving averages as the number of individual samples. The mean ratio of the moving averages now becomes the mean of a distribution of sample means, and the measure of variability of this distribution is the standard error of the mean. Armed with the average range, the sample size, and the mean of the sample means, the standard error of the mean can be obtained directly from statistical tables. Control limits can now be established on the basis of probability, since approximately sixty-eight percent of all the moving averages can be expected to fall within plus or minus one standard error from the average ratio, and approximately ninety-five percent of the sample means can be expected to fall within plus or minus two standard errors from the average ratio. Thus, the Project Director will be able to determine on a probability basis, or at a particular level of confidence, that the variation of the actual costs from the expected performance is or is not due to chance causes. In other words, if the acceptable control limits were set at two standard errors from the expected ratio, and the ratio of actual expenditures to the standards exceeded these limits, it would be concluded that the actual expenditures were not conforming to the budget program, and that the variation was due to other than chance causes. Therefore, the cause for this variation

could be isolated and evaluated in terms of its significance to the overall program.

Illustration of Procedure

In the situation presented previously, the Project Director had developed a budget of estimated costs for each of the twenty-four periods. This was the operating plan for the year, and actual expenditures were expected to conform to this pattern. Therefore, in order to apply quality control procedures, control limits must be developed on the basis of estimated costs. The discussion in the previous paragraphs briefly explains the computations that are involved in establishing control limits from budget information. These computations are shown in Table 2, with a moving average (Column 7) of three periods to smooth out irregularities between periods. This method of developing control limits for expenditure control was presented in an article by Norman N. Barish, New York University, wherein previous expenditure data was used as a basis for expected performance.[5] However, the use of budget information is just as applicable as past performance data, and it also permits application of quality control procedures where information from previous experience is not available. In many ways the use of the budget is more desirable for determining control limits because it is an expression of what the management desires to accomplish, rather than what it has done in the past. Cost control then is on the basis of managerial determination, and conformance to this objective is especially important from a managerial standpoint.

From statistical theory on the distribution of errors, it is possible to make the following statements from the information presented in Table 2:

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[5] Norman N. Barish, "Graphic Control Reporting," The Controller, (June 1952), pp. 268-281.

TABLE 2

COMPUTATIONS FOR OBTAINING CONTROL LIMITS BASED ON BUDGET AND STANDARD EXPENDITURES

Total Budget (1)	Periods Left (2)	Beginning Balance (3)	Total Standard 3/2 (4)	Ratio 1/4 (5)	3 Per. Moving Total (6)	3 Per. Moving Avg. (7)	3 Per. Moving Range (8)
$40,000.00	24	$1,200,000.00	$50,000.00	0.800	-.---	-.---	-.---
45,000.00	23	1,160,000.00	50,434.78	.892	.---	.---	.---
50,000.00	22	1,115,000.00	50,681.82	.987	2.679	0.893	0.187
60,000.00	21	1,065,000.00	50,714.29	1.183	3.062	1.021	.291
55,000.00	20	1,005,000.00	50,250.00	1.095	3.265	1.088	.196
65,000.00	19	950,000.00	50,000.00	1.300	3.578	1.193	.205
45,000.00	18	885,000.00	49,166.67	.915	3.310	1.103	.385
60,000.00	17	840,000.00	49,411.76	1.214	3.429	1.143	.385
55,000.00	16	780,000.00	48,750.00	1.128	3.257	1.086	.299
45,000.00	15	725,000.00	48,333.33	.931	3.273	1.091	.283
40,000.00	14	680,000.00	48,571.43	.824	2.883	.961	.304
35,000.00	13	640,000.00	49,230.77	.711	2.466	.822	.220
35,000.00	12	605,000.00	50,416.67	.694	2.229	.743	.130
45,000.00	11	570,000.00	51,818.18	.868	2.273	.758	.157
55,000.00	10	525,000.00	52,500.00	1.048	2.610	.870	.354
65,000.00	9	470,000.00	52,222.22	1.245	3.161	1.054	.377
50,000.00	8	405,000.00	50,625.00	.988	3.281	1.094	.257
40,000.00	7	355,000.00	50,714.29	.789	3.022	1.007	.456
45,000.00	6	315,000.00	52,500.00	.857	2.634	.878	.199
55,000.00	5	270,000.00	54,000.00	1.019	2.665	.888	.230
65,000.00	4	215,000.00	53,750.00	1.209	3.085	1.028	.352
60,000.00	3	150,000.00	50,000.00	1.200	3.428	1.143	.181
50,000.00	2	90,000.00	45,000.00	1.111	3.520	1.173	.098
40,000.00	1	40,000.00	40,000.00	1.000	3.311	1.104	.200
				Totals		22.141	5.746
				Means		1.006	.261

Standard Error of the Mean Ratio = (.261) (.341)* = .089

Control Limits:

Mean Ratio plus and minus one standard error = 1.095 / .917

Mean Ratio plus and minus two standard error = 1.184 / .828

Mean Ratio plus and minus three standard error = 1.273 / .739

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*Computed from statistical tables. For sample size of three, average range/standard deviation of the population equals 1.693. Therefore, standard error is equal to Average Range/(1.693)(1.732). See Appendix G3, Croxton and Cowden, Practical Business Statistics, p. 517.

1. The expected value for the average of any three consecutive periods is 1.006.
2. The standard error of the mean (.089) is a measure of the amount of variation in the values of the moving averages that can be expected because of the operation of chance factors.
3. If the control limits were set at the expected ratio (1.006) plus and minus two standard errors, and if only chance factors were operating, approximately ninety-five percent of the time it could be expected that the moving averages would fall between the values 1.184 and .828.
4. And, if the control limits were set at plus and minus three standard errors, the moving averages could be expected to fall between the values of 1.273 and .739 approximately ninety-nine point seven percent of the time.

The next step in the control procedure is to determine whether the actual expenditure performance is within the control limits suggested in the previous paragraph. The computations for obtaining this performance data are presented in Table 3. The values obtained for the moving averages (Column 7) can be compared directly with the control limits established above to determine if the actual expenditures conform to the budget plan. In this case, the expected ratio plus and minus two standard errors will be considered the maximum limits within which variations will be accepted as chance fluctuations. The three standard error control limits will be used only as secondary limits to assist in evaluating values that are not acceptable as chance fluctuations. This information can be vividly presented by plotting the actual performance data on a control chart in which control lines are graphically placed to indicate the upper and lower

acceptable limits. Figure 1 is an illustration of an expenditure control chart with control lines placed at the two and three standard error levels, and the actual performance data obtained in Table 3 are plotted for each period.

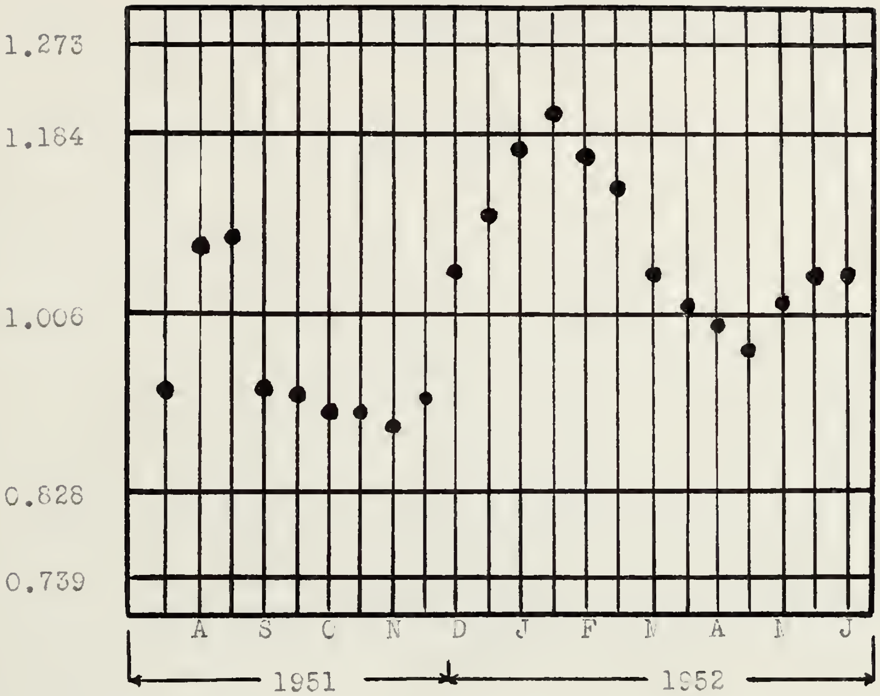
TABLE 3

COMPUTATIONS FOR OBTAINING PERFORMANCE DATA ON ACTUAL EXPENDITURES

Total Actual Costs (1)	Periods Left (2)	Beginning Balance (3)	Total Standard 3/2 (4)	Ratio 1/4 (5)	3 Per. Moving Total (6)	3 Per. Moving Avg. (7)
$34,788.19	24	$1,200,000.00	$50,000.00	0.696	-.---	-.---
44,367.12	23	1,165,211.81	50,661.38	.876	-.---	-.---
62,146.11	22	1,120,844.69	50,947.49	1.220	2.792	0.931
57,396.10	21	1,058,698.58	50,414.22	1.138	3.234	1.078
45,464.13	20	1,001,302.48	50,065.12	.908	3.266	1.089
38,677.14	19	955,838.35	50,307.28	.769	2.815	.938
55,899.27	18	917,161.21	50,953.40	1.097	2.774	.925
42,488.14	17	861,261.94	50,662.47	.839	2.705	.902
39,871.42	16	818,773.80	51,173.36	.779	2.715	.905
55,811.33	15	778,902.38	51,926.83	1.075	2.693	.898
48,019.17	14	723,091.05	51,649.36	.930	2.784	.928
60,111.47	13	675,071.88	51,928.61	1.158	3.163	1.054
62,148.23	12	614,960.41	51,246.70	1.213	3.501	1.100
57,433.89	11	552,812.18	50,255.65	1.143	3.514	1.171
64,899.10	10	495,378.29	49,537.83	1.310	3.622	1.207
50,411.09	9	430,479.19	47,831.02	1.054	3.507	1.169
48,811.13	8	380,068.10	47,508.51	1.027	3.391	1.130
49,614.38	7	331,256.97	47,322.42	1.048	3.129	1.043
44,872.07	6	281,642.59	46,940.43	.956	3.031	1.010
46,813.14	5	236,770.52	47,354.10	.989	2.993	.998
45,811.27	4	189,957.38	47,489.35	.965	2.910	.970
52,117.54	3	144,146.11	48,048.70	1.085	3.039	1.013
49,419.34	2	92,028.57	46,014.29	1.074	3.124	1.041
41,187.19	1	42,609.23	42,609.23	.967	3.126	1.042

FIGURE 1

EXPENDITURE CONTROL CHART



Interpretation of Results

The danger signals in this situation can be easily detected by a brief inspection of the presentation in Figure 1. In this case, the Project Director would have been warned adequately on 1 February 1952 that the budget plan was in danger. On February 16th, another definite signal was given that actual expenditures were not conforming to the estimated costs. From the expenditure reports received on the 1st and 15th of February and on the 1st of March, the Project Director could have concluded that the variations from the budget were not chance fluctuations but were due to certain causes that could be determined and isolated. With this cost control system in operation, the Project Director would not have had the continuing questions in regard to the significance of the variations from the budget. The danger

points would have been detected at the correct moment, and less effort would have been required in evaluating current expenditures with respect to the budget. The merits and advantages of this type of cost control system far outweigh the disadvantages and limitations. However, the limitations in using this type of procedure are important and will be discussed in the following paragraph.

Limitations of the Control Method

In the presentation of expenditure data in Figure 1, control limits were established at the plus and minus two standard error values. One value (1.207) fell outside the upper control limit at 1.184. The conclusion, in accordance with probability theory, is that a value greater than 1.184 can only be expected five times out of a hundred if only chance causes are operating. Therefore, since the probability of a value as large as 1.207 occurring is very small, it is considered to be a significant variation and an investigation should be initiated to determine the cause. Herein lies the limitations to the control procedure. The probabilities stated above are only accurate when the cost data are taken from a normal universe of known characteristics. In this case, the exact nature of the characteristics are not known, which will cause minor changes in the probabilities. Therefore, the probabilities stated previously in regard to the number of values that can be expected to fall within the control limits, are only approximations. But they are useful approximations, and they provide an effective method for obtaining the answers to managerial problems. The danger signals are lighted and the actual pattern or trend is dynamically portrayed by the control chart.

Probably the biggest limitation in the application of statistical control methods to cost control is in the selection of standards. It is

very easy to select standards that will throw the entire situation out of control. This is important because the probability limits only have meaning when the system is in control; that is, when only a constant system of chance causes is operating and none of the variations can be assigned to any particular cause. As a practical rule, a system is considered in control if twenty-five or more consecutive values fall within the control limits established by the three standard error values.[6]

An example of a selection of standards that resulted in the system being out of control is shown in Table 4. This is essentially the same situation as was presented in the previous paragraphs, except that the budget indicates a definite trend, increasing and decreasing at a relatively uniform rate from low expenditures in the beginning and end of the year to high costs in the middle of the period. The fluctuations in this case are not around an average expenditure for the entire period, but they are variations above and below a trend. A suitable standard in this case would be one which varies in the same pattern as the expected costs. Again the variations from the standard would be extended through the remaining periods as was done in Tables 2 and 3. An examination of column (7) in Table 4 shows that ten values exceed the three standard error control limits, and it can be concluded that the variations are due to assignable causes and are not chance fluctuations. Therefore, the procedure is of little value for cost control purposes. The selection of standards is, therefore, an important phase of the control procedure which should be studied carefully. The criteria for useful standards is indicated by the expected pattern of actual costs.

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[6] F. E. Croxton and D. J. Cowden, Practical Business Statistics (New York: Prentice-Hall, Inc., 1949), pp. 396-397.

TABLE 4

COMPUTATIONS FOR BUDGET AND STANDARD COSTS RESULTING IN LACK OF CONTROL

Total Budget (1)	Periods Left (2)	Beginning Balance (3)	Total Standard 3/2 (4)	Ratio 1/4 (5)	2 Mo. Moving Total (6)	2 Mo. Moving Avg. (7)	2 Mo. Moving Range (8)
$35,000.00	24	$1,200,000.00	$50,000.00	0.700	-.---	-.---	-.---
40,000.00	23	1,165,000.00	50,652.17	.790	-.---	-.---	-.---
44,000.00	22	1,125,000.00	51,136.36	.860	-.---	-.---	-.---
48,000.00	21	1,081,000.00	51,476.19	.932	3.282	.821	.232
52,000.00	20	1,033,000.00	51,650.00	1.007	3.589	.897	.217
56,000.00	19	981,000.00	51,631.58	1.085	3.884	.971	.225
58,000.00	18	925,000.00	51,388.89	1.129	4.153	1.038	.197
58,000.00	17	867,000.00	51,000.00	1.137	4.358	1.090	.130
60,000.00	16	809,000.00	50,562.50	1.187	4.538	1.135	.102
62,000.00	15	749,000.00	49,933.33	1.242	4.695	1.174	.113
62,000.00	14	687,000.00	49,071.43	1.263	4.829	1.207	.126
60,000.00	13	625,000.00	48,076.92	1.248	4.940	1.235	.076
58,000.00	12	565,000.00	47,083.33	1.232	4.985	1.246	.031
56,000.00	11	507,000.00	46,090.91	1.215	4.958	1.240	.048
54,000.00	10	451,000.00	45,100.00	1.197	4.892	1.223	.051
52,000.00	9	397,000.00	44,111.11	1.179	4.823	1.206	.053
50,000.00	8	345,000.00	43,125.00	1.159	4.750	1.188	.056
48,000.00	7	295,000.00	42,142.86	1.139	4.674	1.169	.058
46,000.00	6	247,000.00	41,166.67	1.117	4.594	1.149	.062
44,000.00	5	201,000.00	40,200.00	1.094	4.509	1.127	.065
42,000.00	4	157,000.00	39,250.00	1.070	4.420	1.105	.069
40,000.00	3	115,000.00	38,333.33	1.043	4.324	1.081	.074
38,000.00	2	75,000.00	37,500.00	1.013	4.220	1.055	.081
37,000.00	1	37,000.00	37,000.00	1.000	4.126	1.032	.094
				Totals		23.389	2.160
				Means		1.114	.103

Standard Error of the Mean Ratio = (.103) (.243) = .025

Control Limits:

Mean Ratio plus and minus one standard errors	=	1.139 1.089
Mean Ratio plus and minus two standard errors	=	1.164 1.064
Mean Ratio plus and minus three standard errors	=	1.189 1.039

CHAPTER IV

CONCLUSIONS

The cost control method presented in the previous chapter can be applied to many other budget programs. Financial revenue and other types of operational data can be measured and evaluated in the same manner as expenditures. Regardless of the application, the control chart will present a graphic picture of the trends and patterns, and management will be able to determine the critical points by the danger signals that are evidenced in the control chart. Mr. Barish summarized the considerations, in regard to the application of quality control methods in budgetary control, very effectively in the following paragraph.[7]

> Whenever management desires to compare actual performance with some standard or expected, whenever we want to see trends, whenever we seek a graphic determination of whether variations are significant, some form of graphic control report may promote effective administrative performance. However, this reporting technique, like any other method of presentation, will not produce miraculous results by itself. It cannot disclose more information than is inherent in the data, but it can highlight many facts which will clarify management thinking. It cannot disclose directly what has caused significant changes, but it can signal attention to the fact that something has occurred which should be investigated. It is not a substitute for sound judgment and common sense in taking the actions required by each situation, but it can provide the required stimulus to promote managerial action at the correct moments.

As indicated in the above quotation, the control chart is an effective method of graphic reporting which can be utilized to great advantage in

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[7] Norman N. Barish, "Graphic Control Reporting," The Controller, (June 1952), p. 281.

administering a budget program. Thus, statistical quality control methods, although normally used in the production phases of management, can be effectively applied as a tool in budgetary control.

BIBLIOGRAPHY

Books

Buck, Arthur E. Public Budgeting. New York: Harper & Brothers, 1929.

Croxton, F. E., and Cowden, D. J. Practical Business Statistics. New York: Prentice-Hall, Inc., 1949.

Doris, Lillian. Corporate Treasurer's and Controller's Handbook. New York: Prentice-Hall, Inc., 1951.

Grant, E. L. Statistical Quality Control. New York: McGraw-Hill Book Company, Inc., 1946.

Juran, J. M. Quality-Control Handbook. New York: McGraw-Hill Book Company, Inc., 1951.

Kennedy, Clifford W. Quality Control Methods. New York: Prentice-Hall, Inc., 1948.

McKinsey, James O. Budgetary Control. New York: The Ronald Press Company, 1923.

National Industrial Conference Board. Budgetary Control In Manufacturing Industry. New York: National Industrial Conference Board, Inc., 1931.

Riggleman, J. R., and Frisbee, I. N. Business Statistics. New York: McGraw-Hill Book Company, Inc., 1951.

Shewhart, W. A. Economic Control of Quality of Manufactured Product. New York: D. Van Nostrand Company, Inc., 1931.

Articles

Barish, Norman N. "Graphic Control Reporting," The Controller, June, 1952, pp. 268-281.

Gordon, Joel. "Operating Statistics as a Tool of Management," Public Administration Review, Summer, 1944, pp. 189-196.

"Statistical Quality Control," Fortune, December, 1949, pp. 161-168.

Walker, R. A. "The Relation of Budgeting to Program Planning," Public Administration Review, Spring, 1944.

Witten, John D. "Statistics as a Tool of Management," Public Administration Review, Summer, 1944, pp. 279-286.

"Quality Control," Fortune, October, 1943, pp. 127 ff.